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Re-entrant first-order phase transitions and anomalous hysteresis of dipolar Bose gases in a triangular optical lattice DAISUKE YAMAMOTO, Condensed Matter Theory Laboratory, RIKEN, Wako, Saitama 351-0198, Japan, IPPEI DANSHITA, Computational Condensed Matter Physics Laboratory, RIKEN, Wako, Saitama 351-0198, Japan, CARLOS SÁ DE MELO, School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332, USA — We study the hysteresis behavior of dipolar Bose gases loaded into a triangular optical lattice. A large-size cluster mean-field approximation is applied to the corresponding extended Bose-Hubbard model to take into account metastable states. We find that the phase transition between supersolid (or solid) and superfluid states is always first-order except for the particle-hole symmetric point. In the phase diagram, the supersolid and solid phases are sandwiched in between the superfluid phase, and the system exhibits a re-entrant behavior from superfluid to solid (to supersolid), and back to superfluid with varying the chemical potential. Our most remarkable finding is that in the hysteresis accompanying this "re-entrant" first-order phase transition, the quantum melting transition from supersolid or solid to superfluid can occur while the reverse process is impossible since the superfluid phase remains locally stable for any value of the chemical potential. Moreover, the hysteresis curve of density versus chemical potential does not form a "hysteresis-loop" structure unlike the case of the conventional first-order transition. We show that this anomalous behavior of the hysteresis is a common property of systems exhibiting a re-entrant first-order phase transition.

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